

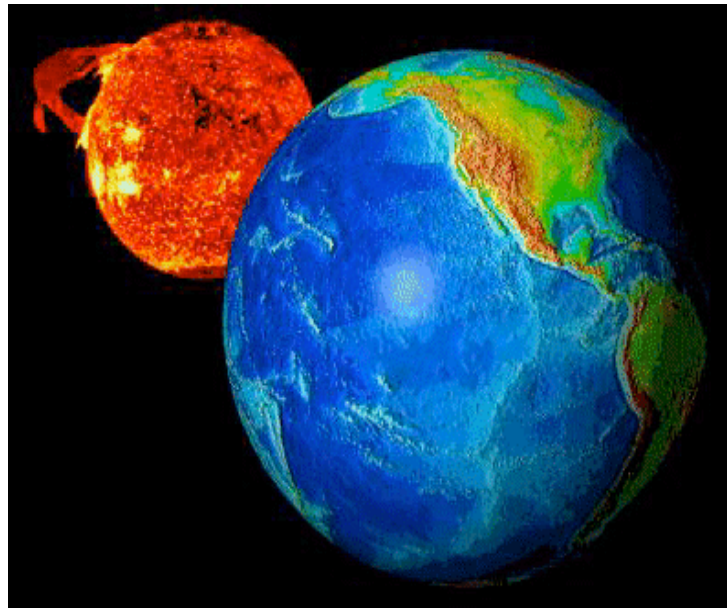


LIVING WITH A STAR DoD PERSPECTIVE



Living With a Star Workshop

11 May 2000



Lt Col Michael F. Bonadonna
HQ USAF Directorate of Weather
Chief, Space Operations Plans



OVERVIEW



BACKGROUND

DoD SWx SUPPORT

LWS PARTNERSHIP



Background



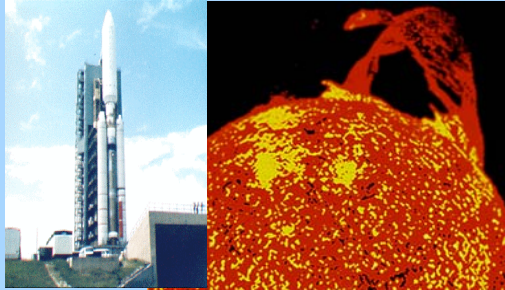
AFW CORE CAPABILITIES

WHAT WE PROVIDE

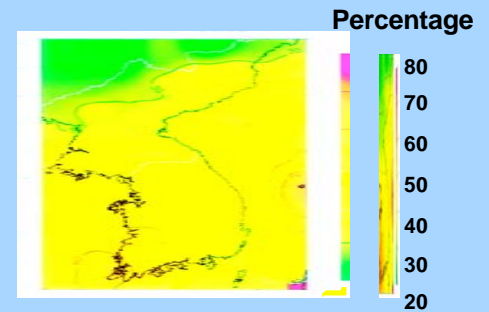
TERRESTRIAL WEATHER



SPACE WEATHER



CLIMATOLOGY



*Ensure Operators
“Exploit the Weather for
Battle”*

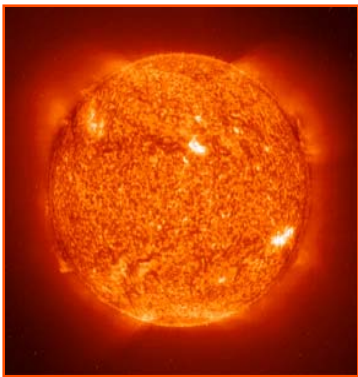


Background



SUPPORT FUNCTIONS

ALL KEY TO PERFORMING AFW'S MISSION



ANALYSIS



TAILORING



DATA COLLECTION



FORECASTING



DISSEMINATION



Background



AEROSPACE ENVIRONMENT

ISSUE

Military Operations Depend on Integrated Air, Land, Sea, and Space Systems

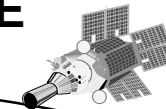
IMPACT

Lack of Timely, Accurate, Relevant Weather Information Will Fracture the Seamless Battlespace

STATUS

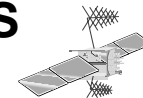
Multi-Hundred Billion Dollar Investment Not Optimized--
**COMBAT EFFECTIVENESS
JEAPORDIZED**

MAGNETOSPHERE



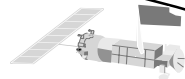
DSP
MILSTAR
DSCS

RADIATION BELTS



GPS

IONOSPHERE



DMSP

MESOSPHERE



SHUTTLE

STRATOSPHERE

U-2



TROPOSPHERE



SEAMLESS BATTLESPACE

Space Weather
Terrestrial Weather



DISTURBANCES AND IMPACTS



Electromagnetic Radiation

EFFECTS

- HF RADIO BLACKOUT
- SATCOM INTERFERENCE
- RADAR INTERFERENCE
- SATELLITE ORBIT DECAY
- GEOLOCATION ERRORS

High Energy Charged Particles

EFFECTS

- SATELLITE DISORIENTATION
- SPACECRAFT DAMAGE
- FALSE SENSOR READINGS
- LAUNCH PAYLOAD FAILURE
- ASTRONAUT HEALTH

Electrically Charged Particle Clouds

EFFECTS

- GEOLOCATION ERRORS
- SATCOM DISRUPTIONS
- SPACECRAFT ANOMALIES
- SATELLITE ORBIT DECAY
- RADAR FALSE TARGETS

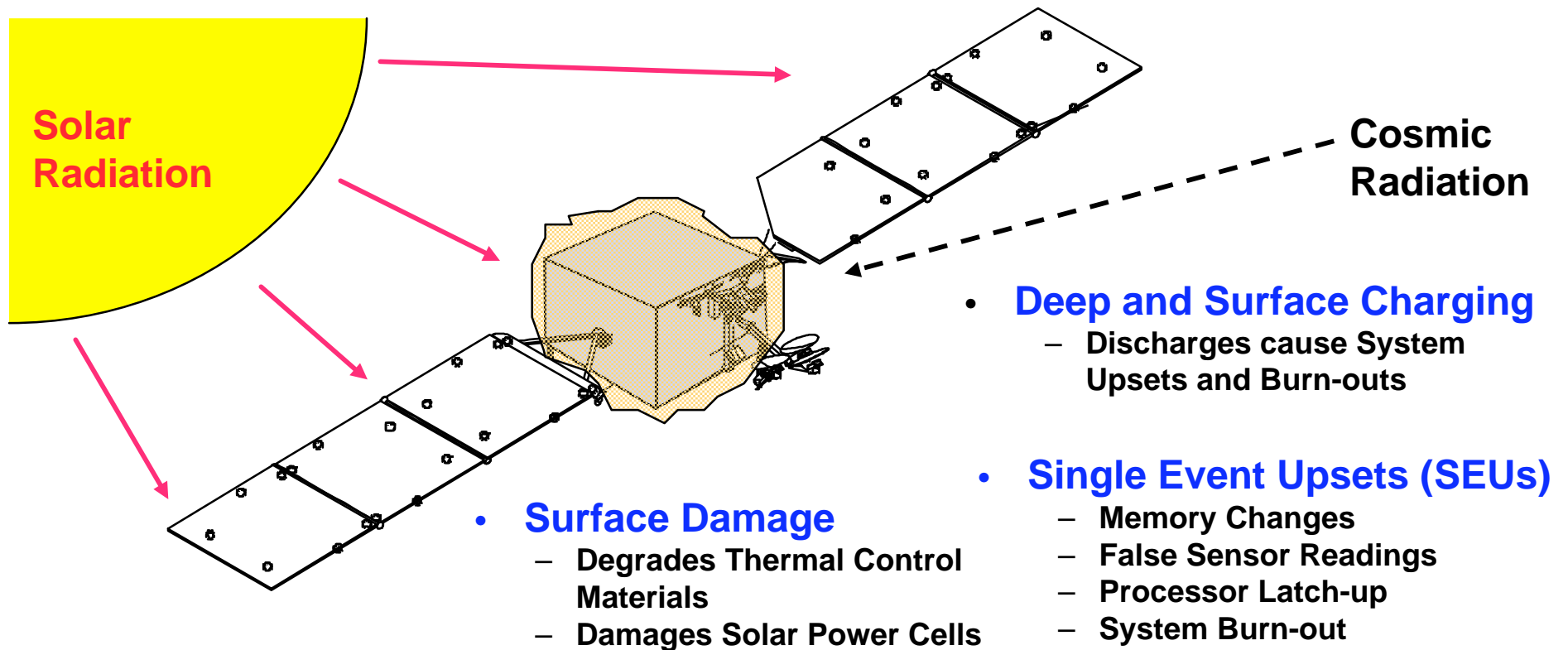
Sample Impacts (Solar Max, 1989)

- SATCOM interruptions (Desert Storm)
- Worldwide HF comm blackouts
- Lost contacts with Air Force One
- Premature satellite orbit decay
- Hundreds of satellite ops disruptions
- Dozens of failed satellite subsystems
- NORAD lost 1300 orbiting objects
- Six million people lost electrical power



DoD Space Weather Support

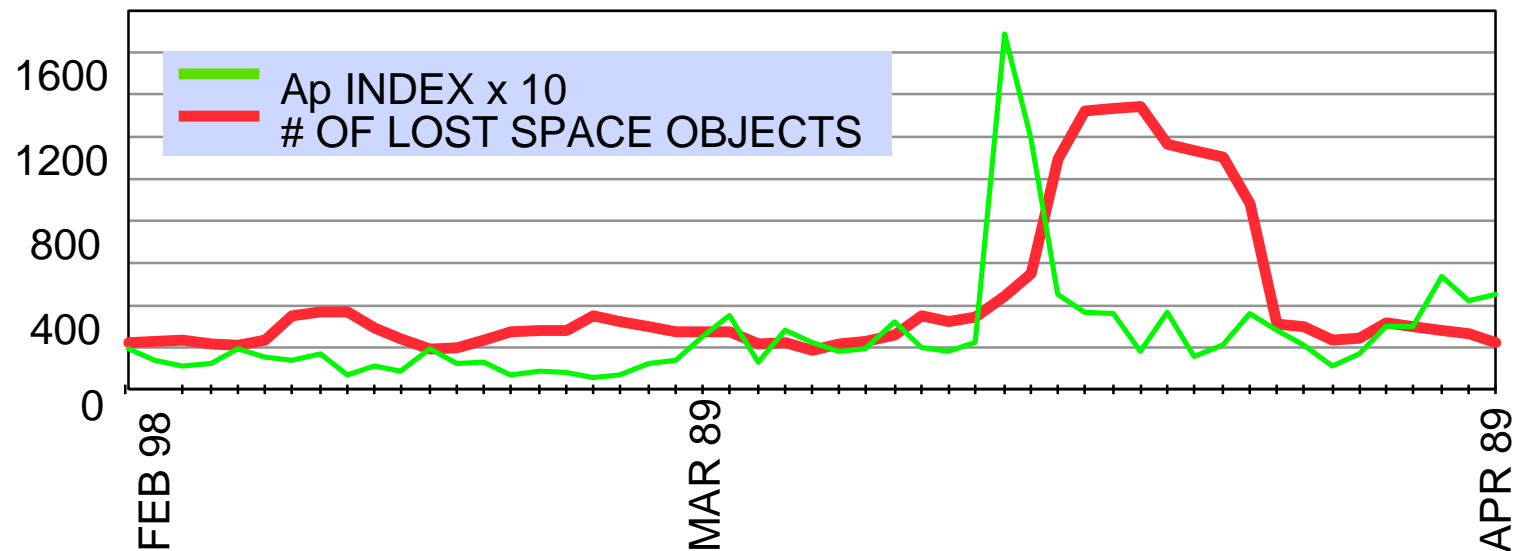
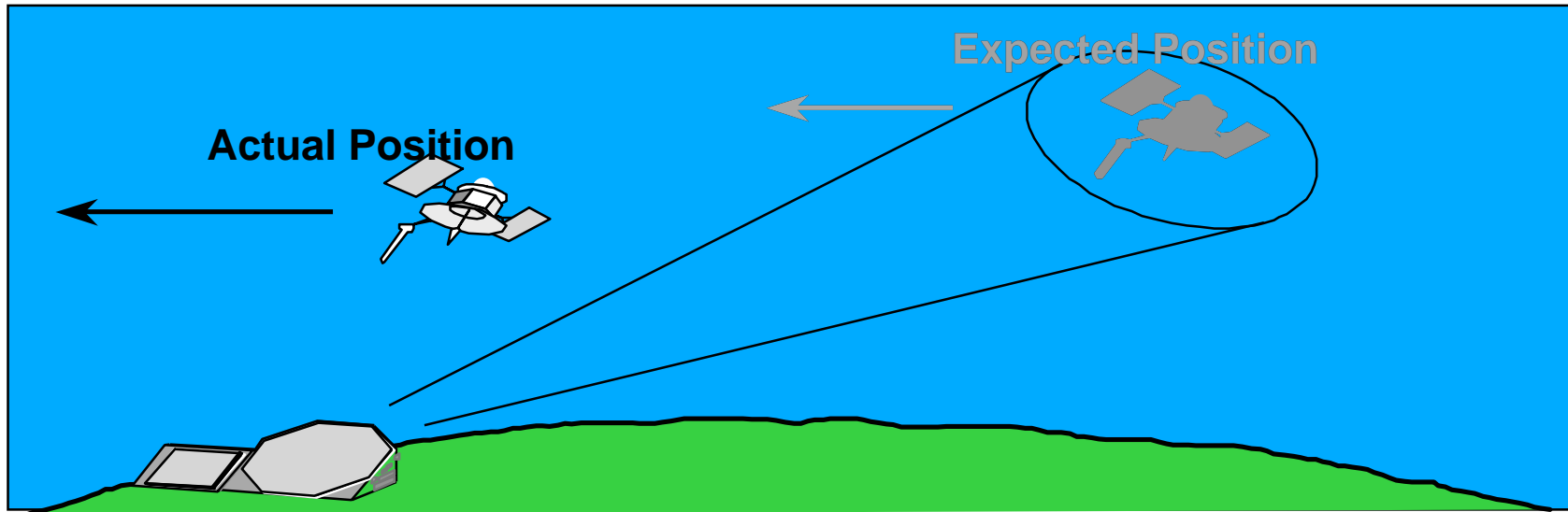
RADIATION EFFECTS ON SPACECRAFT



- Interrupts Mission Support
- Shortens Spacecraft Life
- May Cause Loss of Satellite

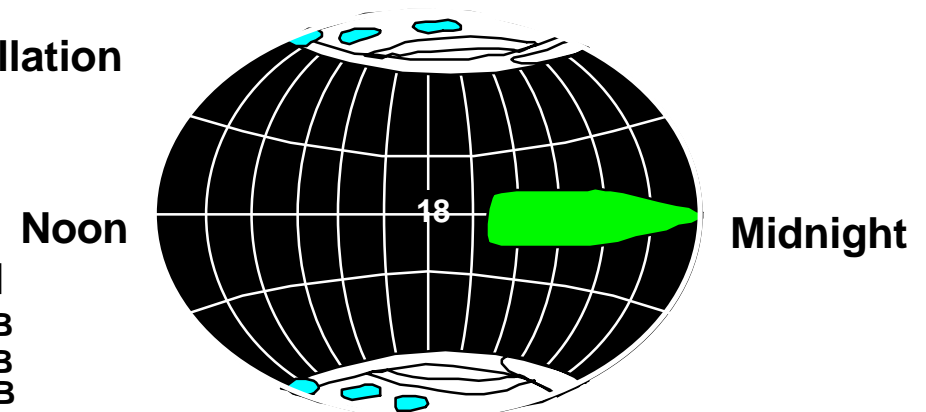
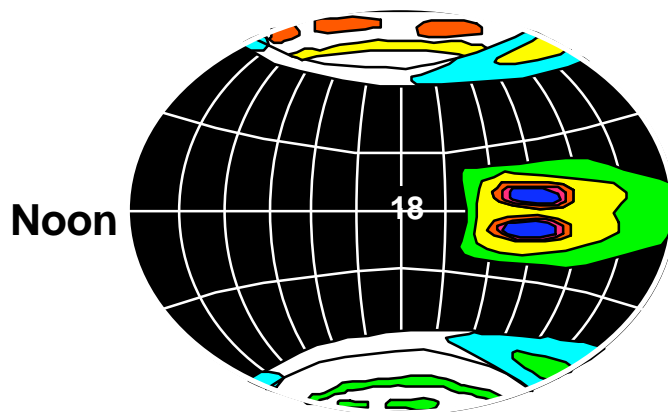
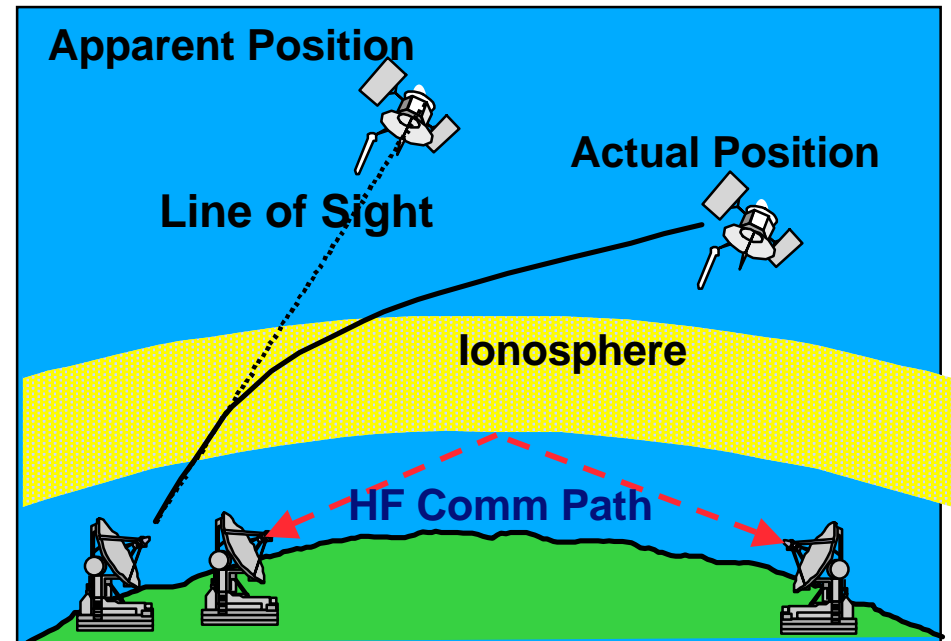
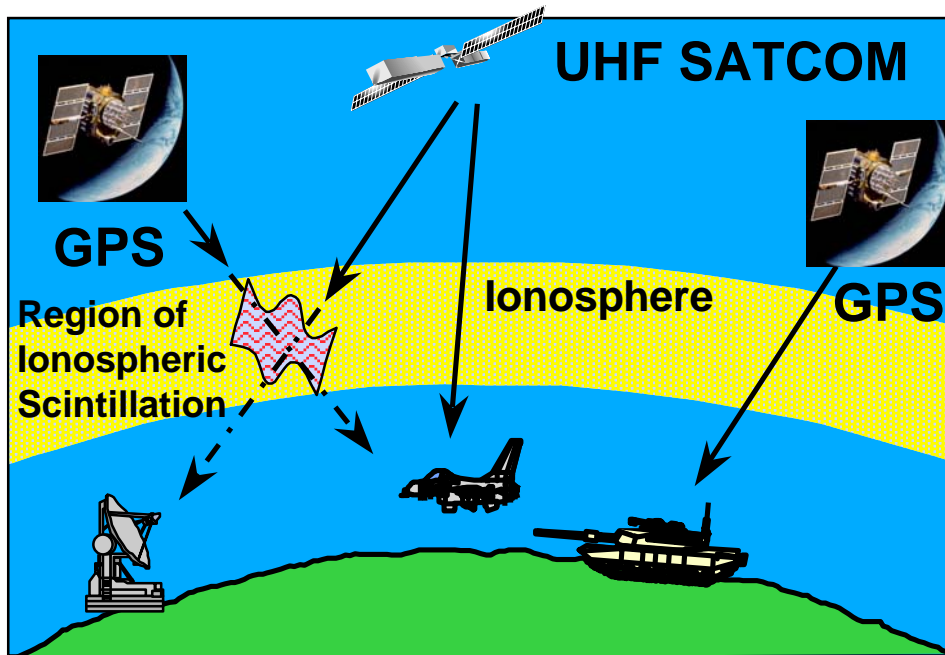


IMPACT ON ORBIT CHANGES





IONOSPHERIC EFFECTS





Space Weather Concerns



SPACE “FOG OF WARFARE”

**GPS Single-Frequency
Tactical Positioning Errors
(Troops, mines, maps)**

**Space Surveillance
Geolocation Errors
(INTEL, Targeting)**

**GPS Dual-Frequency
Loss of Signal Lock
(Precision Navigation,
PGMs, ...)**

**HF Communication
Frequency Disruptions
(Tactical and Allied
Communications)**

**Space-Based Comm
Intermittent Interruptions
(UHF SATCOM data/voice)**

**CUMULATIVE
IMPACTS ON
COMMAND & CONTROL**

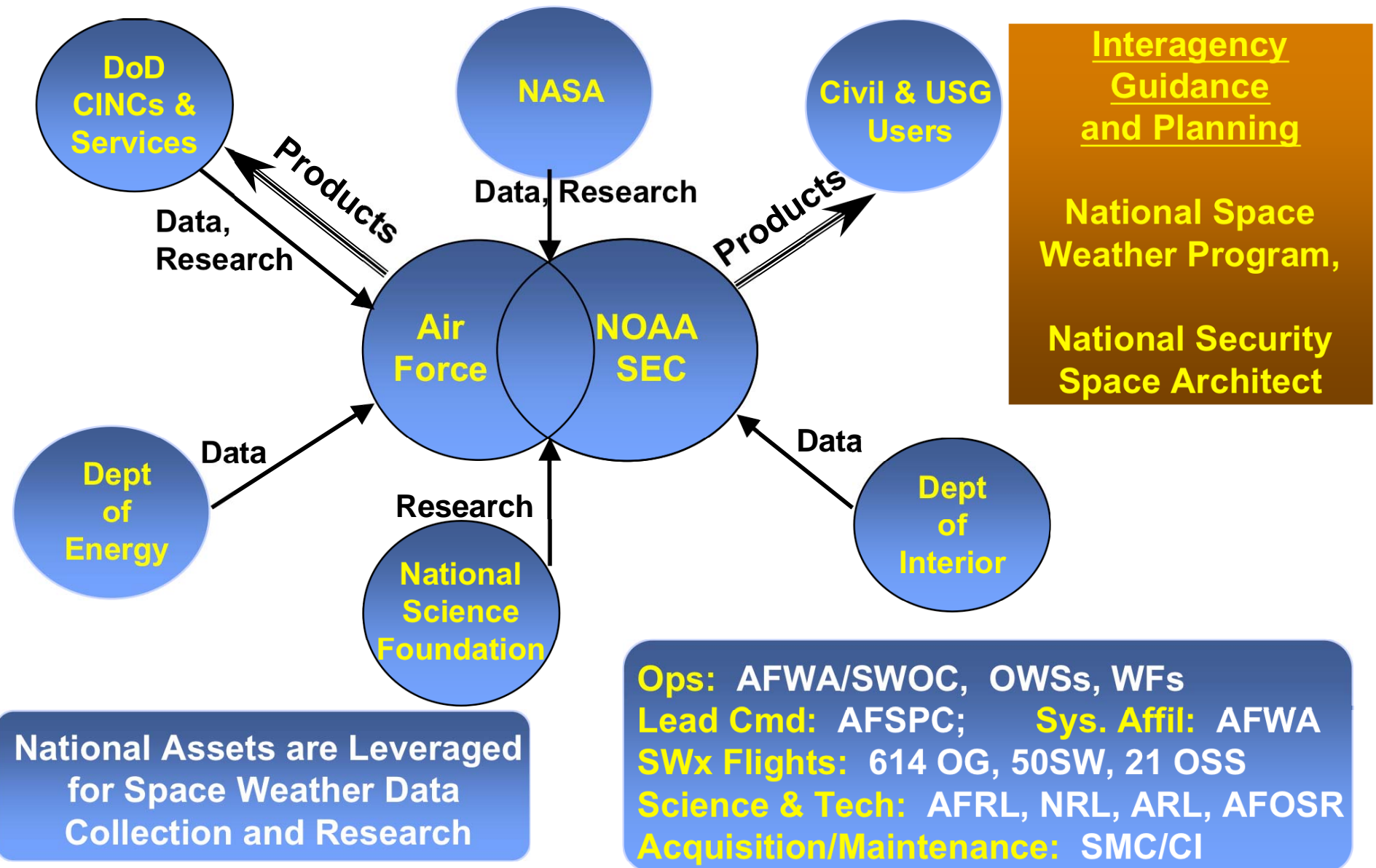
**Space Tracking
Interference, False
Targets, Tracking Errors
(Missile Defense)**



DoD Space Weather Support



NATIONAL SWx SUPPORT





CURRENT SUPPORT STRUCTURE

SPACE SENSORS

DoD

INTERNATIONAL
& NASA

CIVIL

Orbit
Areas

L1

GEO

LEO

SOHO (ISTP)
- Solar activity
- Solar wind
- Solar structure

ACE (NASA)
- Solar particles
- Solar wind
- Interplan. mag field

DSP
- Energetic particles

GPS
- Energetic particles

DMSP
- Aurora
- Magnetic field
- Ionospheric properties
- Energetic particles

Classified
- Energetic particles

POES (NOAA)
- Energetic particles

GOES (NOAA)
- Magnetic fields
- Solar x-rays
- Energetic particles

Yohkoh (Japan)
- Solar x-ray imagery

Polar (ISTP)
- Auroral UV imagery

**Products to
Military Users**

**55th Space
Weather
Squadron
(AFWA)**

**Space
Environment
Center
(NOAA)**

**Products to Civil
Commercial Users**

GROUND SENSORS

**JPL
TEC Monitors**

**Solar Optical
Observing Network**

**Radio Solar
Telescope Network**

**Solar Radio
Spectrograph**

**Magnetometer
Network (USGS)**

**Ionospheric
Measuring System**

**Digital Ionospheric
Sounding System**

Neutron Monitor

Riometer



MISSION AREA ASSESSMENT

Requirements vs Capability

Requirements	Supported Mission Area	Current Support Capability
Scintillation	Comm, PNT, BMD, ISR	Specification (-) Warning Forecast
Electron Density	Comm, PNT, BMD, ISR	Specification Forecast (-)
Radiation and Charging	Spacecraft High Altitude Flight	Specification (-) Warning Forecast
Neutral Density	BMD, ISR	Forecast (-)
GIC	Electric Power	Specification (+) Warning
RFI	BMD, ISR	Specification (+) Warning Forecast
Aurora Clutter	ISR	Specification Warning

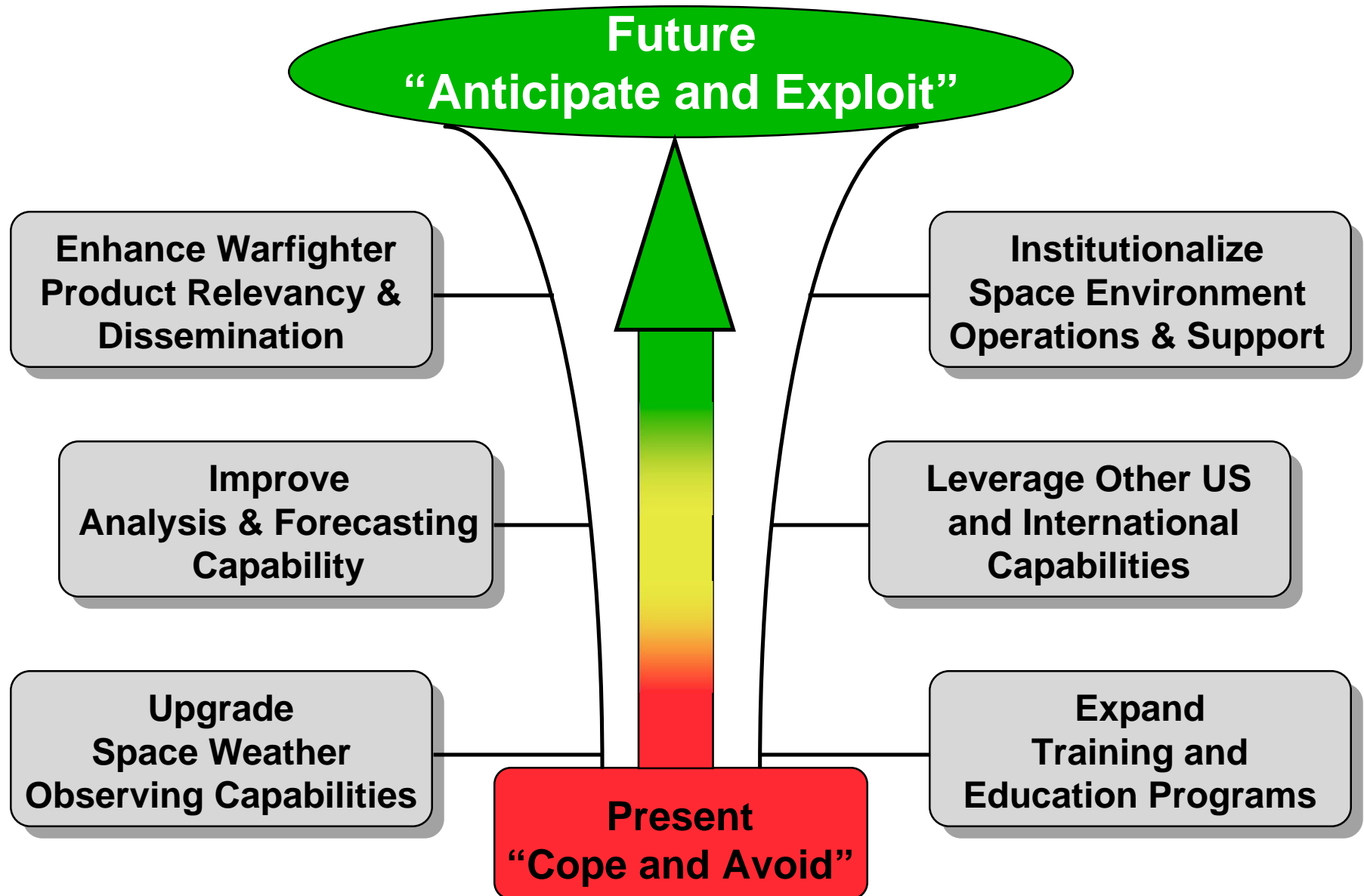
VISION

**Relevant space weather observations and forecasts...
provided to every DoD unit
affected by space weather...
with forward weather forces
identifying support needs
and tailoring products.**





THE WAY AHEAD





Living With a Star Partnership



LWS BENEFITS TO DoD

- ★ **Augment existing data sources and expand the range of observations**
 - Provide data in timely manner for operational use (Near real time)
- ★ **Demonstrate a space weather capabilities applicable to operational support**
 - Leverage technology to build operational systems
 - Provide timely, useful products the space weather centers can use for operations
- ★ **Research to Ops transition assistance**
 - Bridge the gap between science and application leveraging LWS expertise



Living With a Star Partnership



DoD CONTRIBUTION TO LWS

- ★ **Fulfills LWS goal of deriving UTILITY from Science Understanding**
 - Operational perspective
 - Field testing of prototype products and services
 - Direct application of LWS data/products for operational support
- ★ **DoD participation in the CCMC (Community Coordinated Modeling Center)**
 - DoD provides the primary computational resources
 - Aligned with DoD SWx Center (Air Force Weather Agency)
 - Facilitates Interagency participation
- ★ **Data collection?**
 - May leverage Air Force resources to downlink data
 - Precedent set by ACE, CloudSat



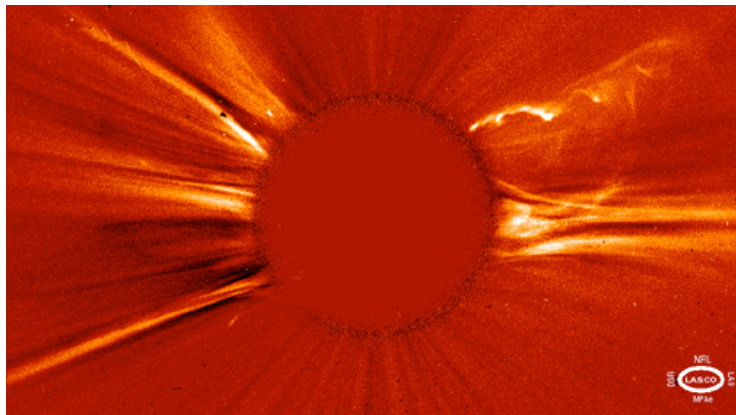
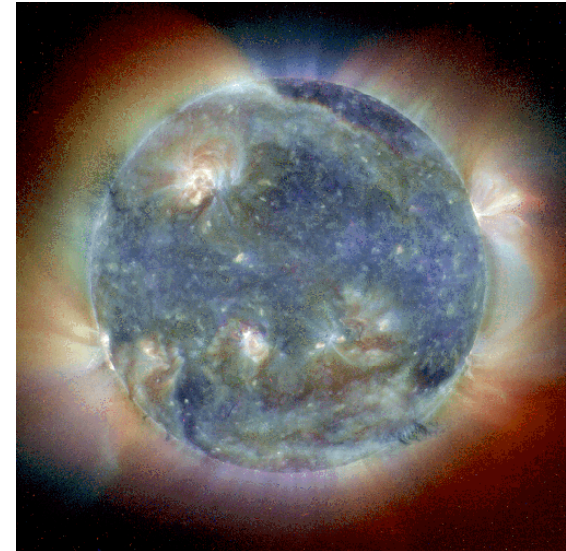
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LWS MISSIONS



- **Solar Dynamics Observatory**

- Observations in UV, EUV, Etc.
(Atmospheric Imaging Assembly)
- Observations of corona for CME detection (Coronal Imaging Assembly)
- Other products as available
(Helioseismograph and Magnetograph)



Solar Sentinels

- Warnings and updates of CMEs directed towards the Earth
- Notification and basic data on far-side flares, CMEs,



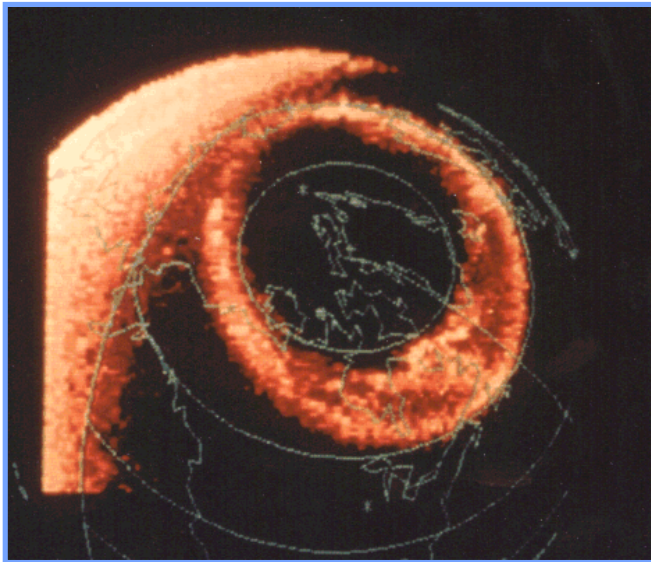
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LWS MISSIONS

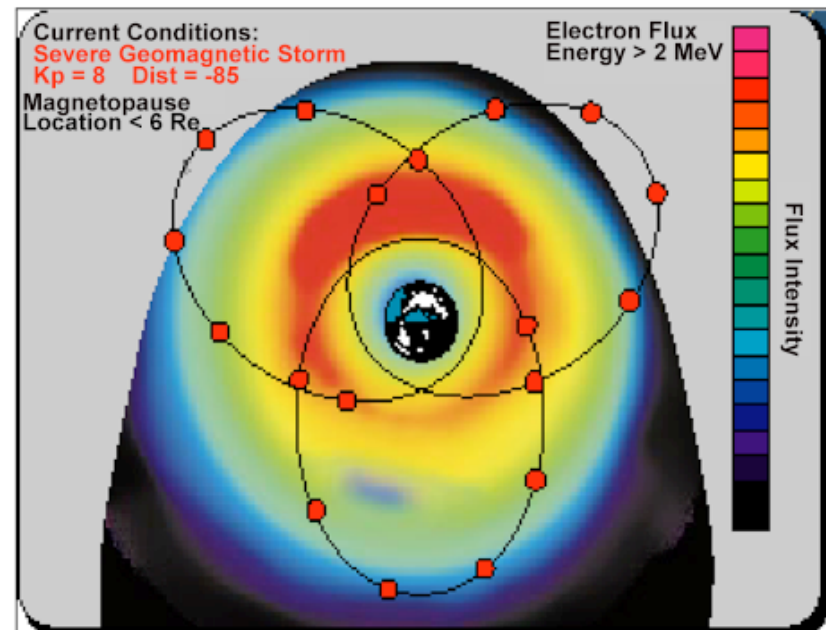
- **Radiation Belt Mappers**

- Full energy/flux ranges of particles
- Data for specification and predictive models
- Empirical and science-driven maps of the SAA, inner, slot, and outer belts



- **Ionospheric Mappers**

- Ionospheric and Auroral characterization,
- Neutral density,
- Upper Atmosphere Airglow



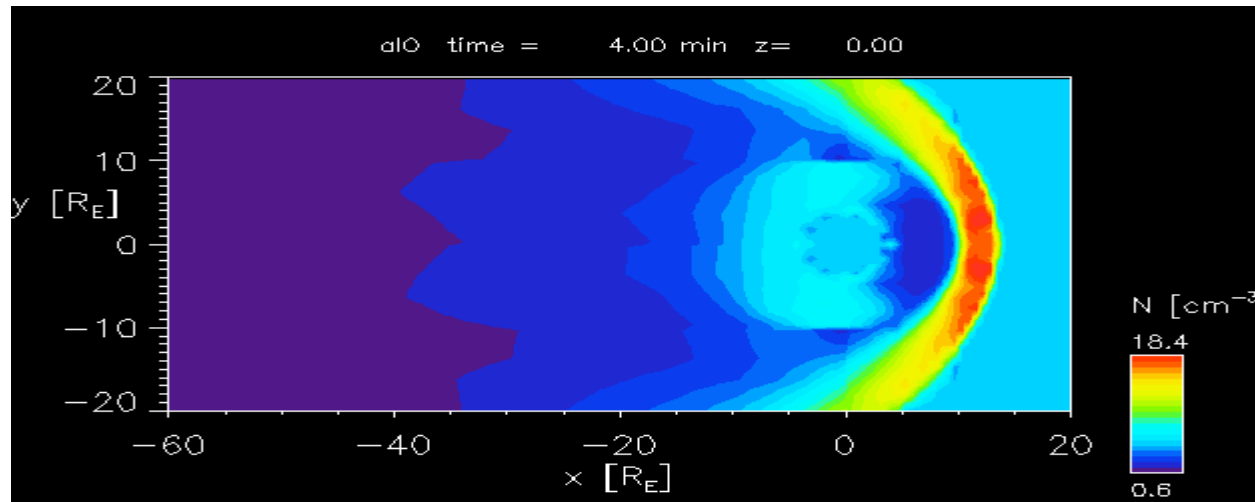


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LWS MISSIONS

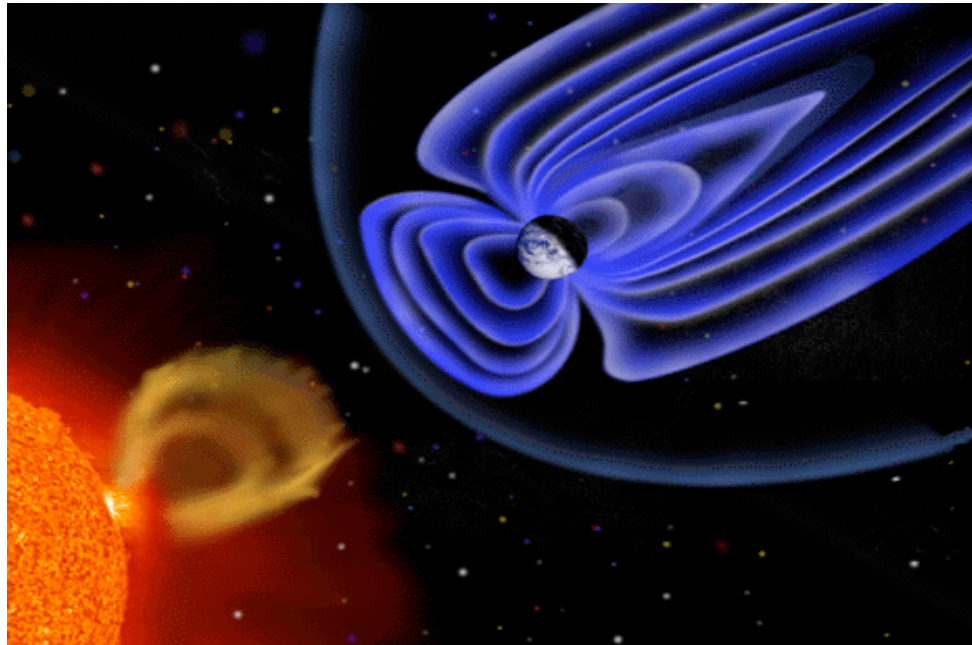
- **Targeted Theory and Modeling**
 - LWS use of CCMC as a path to operations
 - Integrated space environmental domain coupling
 - Emphasis on NSSA SWx Architecture Models List



- **Operations and Data Analysis**
 - Cooperative data processing and analysis
 - Maximize staff interaction
 - Augment the Virtual National Space Environmental Center



BOTTOM LINE



*Ready and eager to participate in the Living
With a Star program to advance the
scientific understanding of the space
environments impact on humanity and
improve operational services*